United States Patent [19]

Schauls

[11] **3,860,065**

[45] **Jan. 14, 1975**

[54] **DISTRIBUTOR FOR PLATE TYPE HEAT EXCHANGER HAVING SIDE HEADERS**

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[73] Assignee: **The Trane Company,** La Crosse, Wis.

[22] Filed: **June 5, 1972**

[21] Appl. No.: **259,744**

Related U.S. Application Data

[63] Continuation-in-part of Ser. Nos. 26,624, April 8, 1970, abandoned, and Ser. No. 128,909, March, 1971, abandoned.

[52] **U.S. Cl.** **165/166**

[51] **Int. Cl.** **F28f 3/00**

[58] **Field of Search** 165/166, 167

[56] **References Cited**

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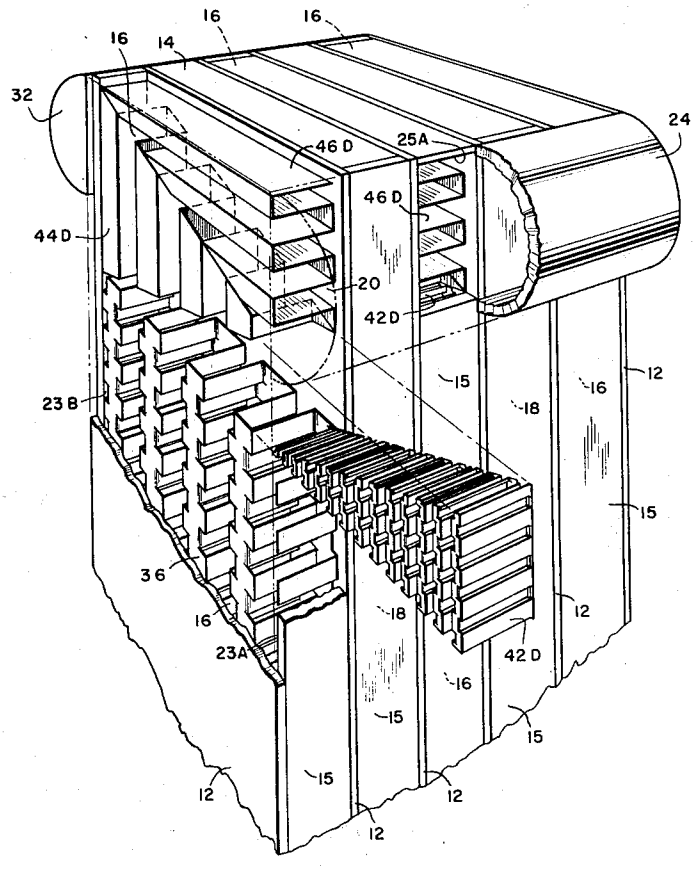
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Primary Examiner—Manuel A. Antonakas
Assistant Examiner—Theophil W. Streule, Jr.

[57] **ABSTRACT**

A plate type heat exchanger is shown having a plurality of rectangular passages disposed in heat exchange relationship through the separator plates thereof. A passage is provided with a port at the side of the heat exchanger adjacent the end thereof for communicating the passage with a side header. Disposed within the heat exchanger passage is a flow distributor or director constructed of metallic corrugated sheet fin material. The distributor contains a wedge shaped section of this corrugated material which has a relatively high resistance to flow therethrough. This wedge section is disposed in a novel orientation to greatly increase the uniformity of fluid flow distribution across the width of the heat exchanger passage. This novel distributor may be used in association with either inlet or outlet side ports. Seven forms of the invention are herein disclosed, of which FIGS. 5, 7, 8, 9 and 10 are claimed as species.

16 Claims, 14 Drawing Figures



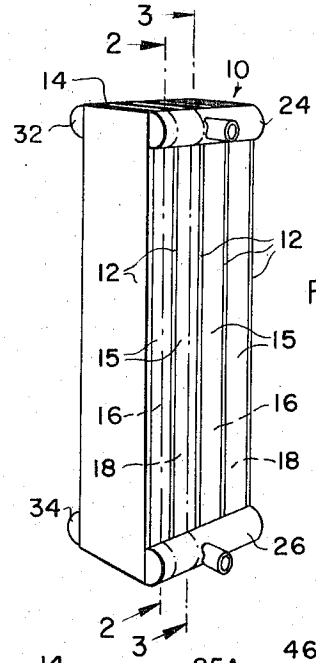


FIG. 1

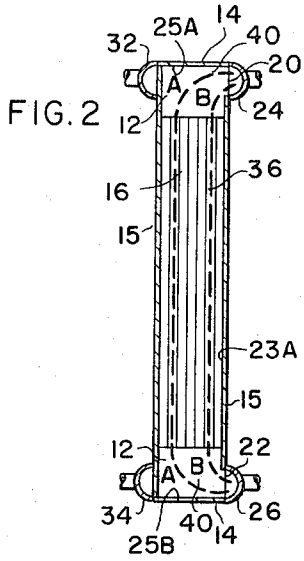


FIG. 2

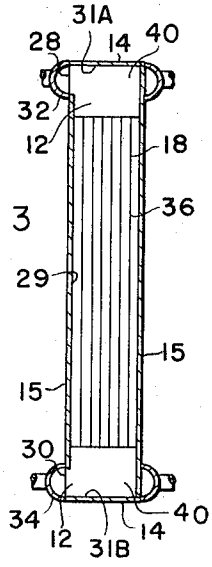


FIG. 3

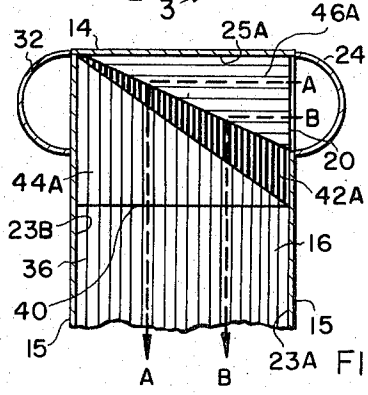


FIG. 4

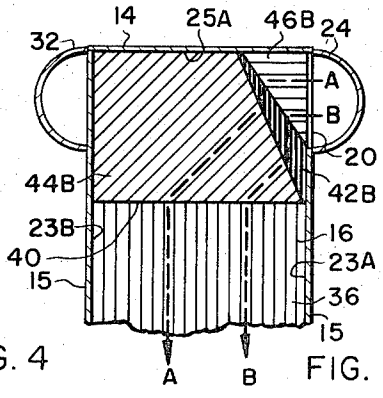


FIG. 5

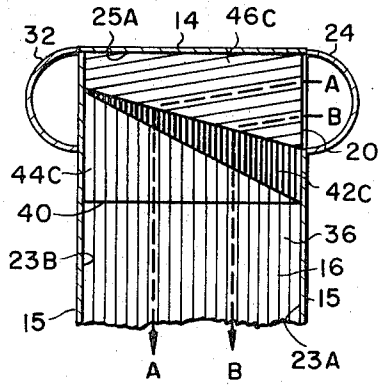


FIG. 6

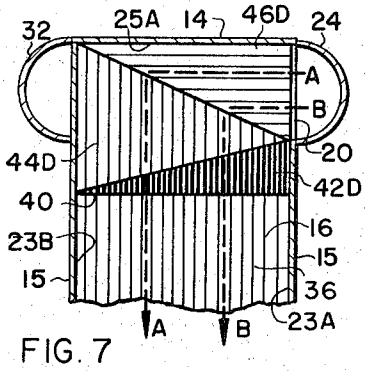


FIG. 7

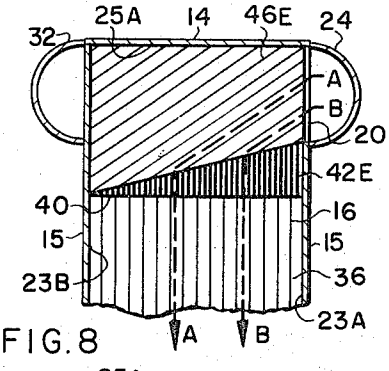


FIG. 8

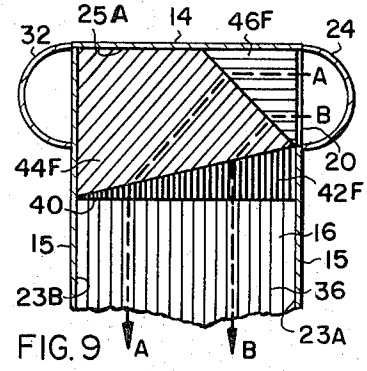


FIG. 9

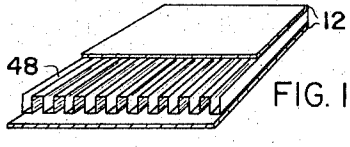


FIG. 11

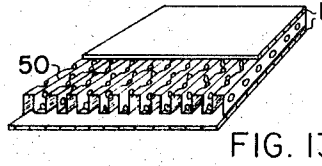


FIG. 13

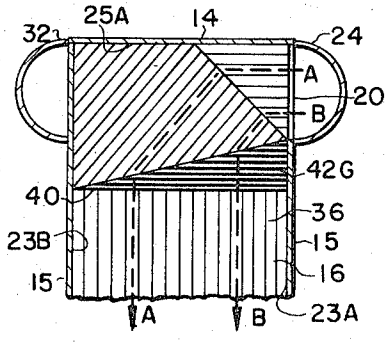


FIG. 10

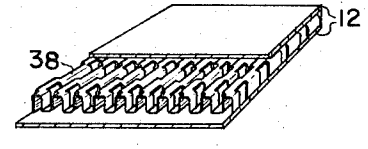


FIG. 12

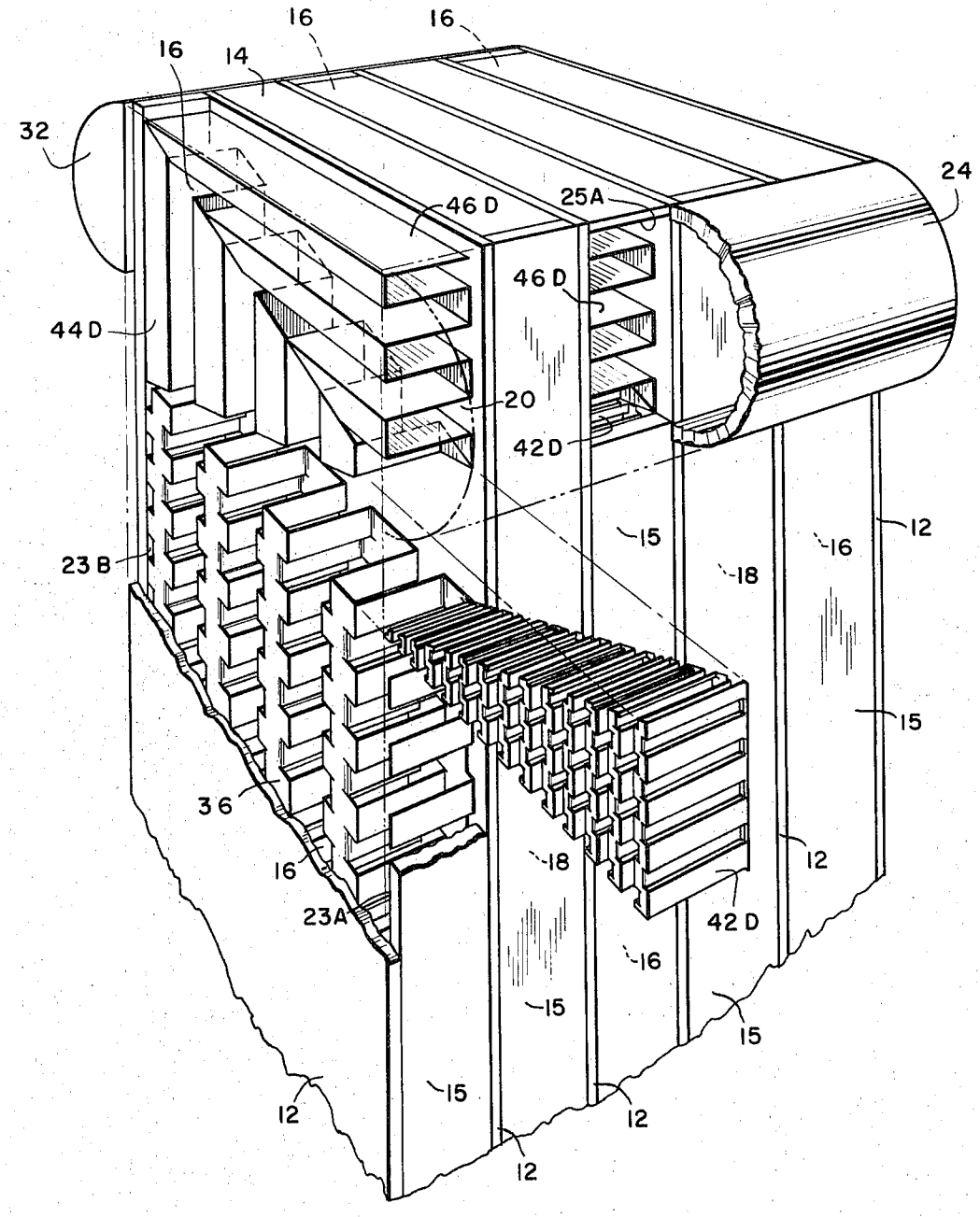

16
16
16
14
32
24
46 D
25A
46 D
44 D
20
42 D
15
16
12
23 B
18
15
36
16
18
12
23A
42 D
16
15
15
15
12
12
12

FIG. 14

DISTRIBUTOR FOR PLATE TYPE HEAT EXCHANGER HAVING SIDE HEADERS

CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Pat. applications Ser. No. 26,624 filed Apr. 8, 1970 now abandoned and Ser. No. 128,909 filed Mar. 29, 1971 now abandoned, both in the name of James J. Schauls.

BACKGROUND OF THE INVENTION

This inventions relates to brazed plate-type heat exchangers having relatively thin generally rectangularly-shaped passages separated by spaced metallic plates. More particularly this invention relates to plate type heat exchangers having a port through the side edge adjacent the end edge thereof. Such passages are commonly provided with various fin material to function as extended heat transfer surface. Such fin materials in the vicinity of the port may also function as a flow distributor for distributing fluid between the port face and the full width of the heat exchanger passage.

SUMMARY OF THE INVENTION

The instant invention provides a fluid flow distributor for a plate type heat exchanger having side ports in which the fluid distributor provides substantially uniform distribution of fluid across the width of the heat exchanger passage.

The distributor includes an elongated wedge or triangular section of metallic corrugated sheet fin material wherein the longest extent of said wedge extends transversely to the passage and has its wider end disposed adjacent to the port side of the passage next to but not overlying the port. The wedge section has a comparatively higher resistance to fluid flow therethrough per unit length in the direction of fluid flow than the average resistance to fluid flow per unit length in the direction of fluid flow for the remainder of the fin material within the distributor as well as the passage.

Other aspects and advantages of the instant invention will become apparent as this specification proceeds to describe the invention with reference to the accompanying drawings in which

FIG. 1 is a perspective of a plate type heat exchanger embodying the instant invention;

FIG. 2 is a section taken along line 2—2 of FIG. 1 through one of the heat exchange passages and having the fin material of the flow distributors removed to more clearly show the distributor areas adjacent the side port of the passage;

FIG. 3 is a section similar to FIG. 2 taken along line 3—3 of FIG. 1 through another of the heat exchanger passages;

FIG. 4 is an enlargement of a portion of the passage of FIG. 2 showing a first form of flow distributor structure within the distributor area of the passage which structure embodies an elongated wedge of high flow resistance metallic corrugated sheet fin material extending from its wider end just below the side port at the port side of the passage to its narrower end across the passage.

FIGS. 5–10 are similar to FIG. 4 showing additional embodiments of the novel flow distributor all of which embody a wedge of high flow resistance material extending across the flow path of the passage and having its wider end disposed adjacent but not overlying the port face;

FIG. 11 is a perspective illustrating one form of metallic corrugated sheet fin material between a pair of plates used in the heat exchanger;

FIG. 12 is a perspective illustrating a second form of metallic corrugated sheet fin material between a pair of plates in which the spans between the crests thereof are slit or serrated;

FIG. 13 is a perspective illustrating a third form of metallic corrugated sheet fin material between a pair of plates in which the sheet is provided with a plurality of pores or apertures; and

FIG. 14 is an enlarged perspective of the heat exchanger disclosed in FIG. 7 having portions of the side plate 12 and header 24 broken away and the wedge shaped section 42D displaced to facilitate visual understanding of the fin material within the distributor portion of passage 16 thereof.

Now referring to the drawings it will be seen that the heat exchanger 10 has a plurality of rectangular plates 12 of generally similar peripheral configuration contraposed in spaced parallel relationship. The length of each plate exceeds its width by a factor of more than six. The relatively thin spaces between the plates 12 are sealingly enclosed by a series of passage closing end and side bars 14 and 15 respectively brazed bonded to plates 12 at the end and side margins thereof to thereby define a plurality of relatively thin rectangular passages intermediate each pair of adjacent plates 12, the longitudinal axis of which is parallel to the major axis of the rectangular plates 12 as well as bars 15. For purposes of illustration adjacent passages 16 and 18 are shown in FIGS. 2 and 3 respectively. Passage 16 is proveded with inlet and outlet ports 20 and 22 respectively through one side, i.e., one longitudinal edge 23A of passage 16 adjacent the passage ends 25A and 25B respectively for communication with headers 24 and 26 respectively. Passage 18 is correspondingly provided with ports 28 and 30 through another longitudinal edge 29 adjacent the passage ends 31A and 31B for communication with headers 32 and 34 respectively. Each of the plural passages 16 is correspondingly connected to headers 24 and 26 and each of plural passages 18 is correspondingly connected to headers 32 and 34.

Each pair of adjacent passages 16 and 18 are disposed in heat exchange relationship through the intermediate rectangular plate 12 separating the adjacent passages. Each of passages 16 and 18 is further provided with a packing comprising a rectangular section 36 of metallic corrugated sheet fin material preferably of the well-known serrated construction 38 illustrated in FIG. 12. The purpose of section 36 is to function as extended heat transfer surface. As with all the sections of metallic corrugated sheet fin material hereinafter described, the crests thereof are preferably braze bonded to the adjacent plates 12 throughout.

In accordance with the invention the distributor areas 40 of each of passages 16 and 18 as shown in FIGS. 2 and 3 may be provided with any of the flow distributor structures illustrated in FIGS. 4–10 each form of which includes an elongated wedge section (indicated generally by numeral 42 with a letter suffix) of metallic corrugated sheet fin material having a comparatively high resistance to fluid flow therethrough per unit length in the direction of fluid flow. Dashed lines A—A and B—B in FIG. 2 illustrate generally the direc-

tion of fluid flow path within passage **16.** The direction of flow paths is more accurately represented by dashed lines A—A and B—B in FIGS. **4–10** for the various distributor constructions shown.

The flow distributor shown in FIG. **4** has first and second triangular sections **44A** and **46A** in addition to the aforementioned elongated wedge section **42A.** The wedge section **42A** extends from its widest end which abuts the first longitudinal edge **23A** of passage **16** just below side port **20** and traverses the flow path in passage **16** (as depicted by dashed lines A—A and B—B) to its narrowest end at the intersection of the second longitudinal edge **23B** and the first end edge **25A** of passage **16.** The first triangular section **44A** fills the void between wedge section **42A** and rectangular packing section **36** while second triangular section **46A** fills the void between wedge section **42A** and side port **20.** Sections **44A** and **46A** are constructed of metallic corrugated sheet fin material **48** represented in FIG. **11** while wedge section **42A** is constructed of a metallic corrugated sheet fin material **38** of the type represented in FIG. **12.** The crests of the corrugations of section **46A** are normal to the longitudinal edge **23A** while the crests of the corrugations of sections **42A** and **44A** are parallel to the longitudinal edge **23A.**

The flow distributor shown in FIG. **5** has first trapezoidal section **44B** and second triangular section **46B** in addition to the elongated wedge section **42B.** The wedge section **42B** extends from its widest end which abuts the first longitudinal edge **23A** of passage **16** just below side port **20** and traverses the flow path in passage **16** (as depicted by dashed lines A—A and B—B) to its narrowest end at a point adjacent the first end edge **25A** and spaced from first and second longitudinal edges **23A** and **23B** of passage **16.** The first trapezoidal section **44A** fills the void between the wedge section **42B** and rectangular section **36** while the second triangular section **46B** fills the void between wedge section **42B** and side port **20.** Sections **44B** and **46B** may be constructed of metallic corrugated sheet fin material **48** represented in FIG. **11** while wedge section **42B** is constructed of metallic corrugated sheet fin material **38** of the type represented in FIG. **12.** The crests of the corrugations of section **46B** are normal to the edge **23A** while the crests of the corrugations of section **42B** are parallel to edge **23A.** The crests of the corrugations of section **44B** are oblique to edge **23A** and extend between adjacent edges of sections **42B** and **36.**

The flow distributor shown in FIG. **6** has a first triangular section **44C** and a second trapezoidal section **46C** in addition to the aforementioned elongated wedge section **42C.** The wedge section **42C** extends from its widest end which abuts the first longitudinal edge **23A** of passage **16** just below side port **20** and traverses the flow path in passage **16** (as depicted by dashed lines A—A and B—B) to its narrowest end at the second longitudinal edge **23B** spaced from the first end edge **25A** of passage **16.** The first trapezoidal section **44C** fills the void between wedge section **42C** and rectangular packing section **36** while the second triangular section **46C** fills the void between wedge section **42C** and side port **20.** Sections **44C** and **46C** may be constructed of metallic corrugated sheet fin material **48** represented in FIG. **11** while the wedge section **42C** is preferably constructed of metallic corrugated sheet fin material **38** of the type represented in FIG. **12.** The crests of the corrugations of sections **42C** and **44C** are parallel to edge **23A** while the crests of the corrugations of section **46C** are oblique to edge **23A** and extend from wedge section **42C** to port **20.**

The flow distributor shown in FIG. **7** has first and second triangular sections **44D** and **46D** in addition to the aforementioned elongated wedge section **42D.** The wedge section **42D** extends from its widest end which abuts the first longitudinal edge **23A** of passage **16** just below side port **20** and traverse the flow in passage **16** (as depicted by dashed lines A—A and B—B) to its narrowest end at the second longitudinal edge **23B** of passage **16.** The lower edge of wedge section **42D** is normal to longitudinal edges **23A** and **23B** while the upper edge is inclined and extends upwardly to the lower corner of port **20.** The first triangular section **44D** is located immediately above wedge section **42D** while second triangular section **46D** extends between the first triangular section **44D** and port **20.** The sections **44D** and **46D** are constructed of metallic corrugated sheet fin material **48** represented in FIG. **11** while wedge section **42D** is constructed of metallic corrugated sheet fin material **38** of the type represented in FIG. **12.** The crests of the corrugations of sections **42D** and **44D** are parallel to longitudinal edge **23A** while the crests of the corrugations of section **46D** are normal to longitudinal edge **23A.**

The flow distributor shown in FIG. **8** has a second trapezoidal section **46E** in addition to the aforementioned elongated wedge section **42E.** The wedge section **42E** extends from its widest end which abuts the first longitudinal edge **23A** of passage **16** just below side port **20** and traverses the flow path in passage **16** (as depicted by dashed lines A—A and B—B) to its narrowest end at the second longitudinal edge **23B** of passage **16.** The lower edge of wedge section **42E** is normal to longitudinal edges **23A** and **23B** while the upper edge of wedge section **42E** extends upwardly and toward the lower end of side port **20.** The trapezoidal second section **46E** fills the void between wedge section **42E** and side port **20.** Section **46E** may be constructed of metallic corrugated sheet fin material **48** represented in FIG. **11** while wedge section **42E** is constructed of metallic corrugated sheet fin material of the type represented in FIG. **12.** The crests of the corrugations of the section **46E** are inclined to edge **23A** extending from the upper edge of wedge section **42E** to port **20** while the crests of the corrugations of section **42E** are parallel to the longitudinal edge **23A** of passage **16.**

The flow distributor shown in FIG. **9** has a first tetrahedral section **44F** and a second triangular section **46F** in addition to the aforementioned elongated wedge section **42F.** The wedge section **42F** extends from its widest end which abuts the first longitudinal edge **23A** of passage **16** just below side port **20** and traverses the flow path in passage **16** (as depicted by dashed lines A—A and B—B) to its narrowest end adjacent the second longitudinal edge **23B** of passage **16.** The lower edge of wedge section **42F** is normal to longitudinal edges **23A** and **23B** while the upper edge is inclined upwardly to the lower end of port **20.** The first tetrahedral section **44F** is disposed immediately above the upper edge of wedge section **42F** while the triangular section **46F** is disposed between the section **44F** and side port **20.** Sections **44F** and **46F** are constructed of metallic corrugated sheet fin material **48** represented in FIG. **11** while wedge section **42F** is constructed of metallic cor-

rugated sheet fin material **38** of the type represented in FIG. **12.** The crests of the corrugations of section **46F** are normal to longitudinal edge **23A** while the crests of the corrugations of wedge section **42F** are parallel to longitudinal edge **23A.** The crests of the corrugations of the tetrahedral section **44F** are oblique to longitudinal edge **23A** and inclined from the upper edge of wedge section **42F** to the triangular section **46F.**

The flow distributor shown in FIG. **10** is substantially the same as that shown in FIG. **9** except that the crests of the corrugations in the wedge section **42G** thereof are normal to the longitudinal edges **23A** and **23B,** i.e., normal to the path of fluid flow therethrough. For this reason it is required that wedge section **42G** be porous. It is preferred that section **42G** be constructed of a metallic corrugated porous sheet fin material **50** such as represented in FIG. **13.**

The fin material of which sections **42A** through **42G** are constructed is selected to have a comparatively higher resistance to fluid flow therethrough per unit length, in the direction of fluid flow, i.e., in a direction of the dashed lines A—A and B—B therethrough, than the average resistance to fluid flow per unit length in the direction of fluid flow for the remainder of the fin material in the distributor as well as in the remainder of passage **16** for the particular embodiment shown. This is represented in the drawings by the more closely spaced corrugations for sections **42A-42G.** It should be understood, however, that other fin parameters than corrugation spacing also affect the flow resistance in the corrugated sheet fin material such as sheet thickness, spacing and size of serrations or pores all of which is well known to those having ordinary skill in the art.

The various distributor embodiments disclosed in FIGS. **4–10** suggest that considerable variations may be made. Thus it will be seen that some distributor embodiments are constructed of only two sections while others have three sections. Some sections are triangular while others are rectangular and still others tetrahedral. While three forms of metallic corrugated sheet fin material have been disclosed, others could be adapted to the invention.

What is common to these various embodiments is that they all involve a side port distributor, i.e., a distributor that imparts about 90° net turn to the fluid in passing between the passage and the port. Further they all employ a uniquely shaped and oriented wedge section **42.** Section **42** is shaped and oriented so that fluid passing closest to the port side of the passage travels further in the section **42** than the fluid passing farthest from the port side. Thus note that the length of B—B is greater than A—A in section **42** while the length of A—A is greater than B—B when considering the entire distributor area **40.** It will thus be apparent that by its higher flow resistance and its unique shape and orientation, section **42** can be constructed to counter balance unequal pressure drops found in present day side port distributors. This is accomplished through the shape, orientation and flow resistance of elongated wedge section **42** which has its widest end adjacent but not overlying the side port and extends across the flow path.

Having now described the preferred embodiments of my invention, I contemplate that many changes may be made without departing from the scope or spirit of my invention and I accordingly desire to be limited only by the claims.

I claim:

1. In an elongated plate type heat exchanger having a plurality of elongated plates of generally similar peripheral configuration contraposed in spaced substantially parallel relationship wherein the distances between adjacent plates individually are substantially less than the width of said plates thereby defining a plurality of relatively thin spatial layers therebetween, sealing means sealingly bridging between and extending along the margins of adjacent plates whereby said spatial layers are substantially enclosed to define a plurality of elongated passages each having a thickness less than its width and a width less than its length at least one of said passages having first and second longitudinal edges spaced by the width of said one passage and first and second end edges spaced by the length of said passage, said one passage having an inlet and outlet openings for ingress and egress of a heat exchange fluid, one of said openings being a port communicating with said one passage through said first longitudinal edge adjacent said first end edge of said one passage, and metallic corrugated sheet fin material extending substantially throughout said one passage between said inlet and outlet openings; the improvement comprising: an improved fluid distributor wherein said fin material includes an elongated wedge section of said material having its longest extent extending transversely of the flow path in said one passage and having its wider end terminating adjacent to said port and longitudinally inwardly of said one passage beyond said port at said first longitudinal edge; said section having a comparatively higher resistance to fluid flow therethrough per unit length in the direction of fluid flow than the average resistance to fluid flow per unit length in the direction of fluid flow for the remainder of said fin material in said one passage.

2. The apparatus as defined by claim **1** wherein the narrowest end of said wedge section is disposed at said first end edge of said passage and substantially displaced from said first longitudinal edge.

3. The apparatus as defined by claim **2** wherein the narrowest end of said wedge section is substantially displaced from said second longitudinal edge.

4. The apparatus as defined by claim **1** wherein the narrowest end of said wedge section is disposed at said second longitudinal edge.

5. The apparatus as defined by claim **4** wherein the narrowest end of said wedge section is spaced from said first end edge.

6. The apparatus as defined by claim **1** wherein one of the two longest edges of said elongated wedge section is substantially normal to said first longitudinal edge of said one passage and the other of said two longest edges is oblique to said first longitudinal edge of said one passage.

7. The apparatus as defined by claim **6** wherein said one edge of said wedge section is spaced from said port and the other of said two longest edges terminates adjacent said port.

8. The apparatus as defined by claim **6** wherein said remainder of said fin material includes corrugated fin material having crests oblique to said first longitudinal edge extending substantially from said wedge section substantially to said port.

9. The apparatus as defined by claim **1** wherein said remainder of said fin material includes a first section disposed between said wedge section and said port wherein the crests of the corrugations of said first sec-

tion are oblique to said first longitudinal edge of said one passage.

10. The apparatus as defined by claim **9** wherein said remainder of said fin material includes a second section disposed between said first section and said port wherein the crests of the corrugations of said second section are substantially normal to said first longitudinal edge.

11. The apparatus as defined by claim **10** wherein the crests of the corrugations of said wedge section are substantially parallel to said first longitudinal edge of said one passage.

12. The apparatus as defined by claim **1** wherein the crests of the corrugations of said wedge section are substantially parallel to said first longitudinal edge of said one passage.

13. The apparatus as defined by claim **1** wherein the crests of the corrugations of said wedge section are substantially normal to said first longitudinal edge of said one passage.

14. The apparatus as defined by claim **1** wherein said remainder of said fin material includes a first and second section of said fin material disposed between said wedge section and said port wherein the crests of the corrugations of said first section are substantially parallel to said first longitudinal edge and the crests of the corrugations of said second section are substantially normal to said first longitudinal edge.

15. The apparatus as defined by claim **1** wherein said remainder of said fin material includes a second section disposed between said wedge section and said port wherein the crests of the corrugations of said second section are substantially normal to said first longitudinal edge.

16. The apparatus as defined by claim **1** wherein said remainder of said fin material includes first and second sections of said fin material disposed between said wedge section and said port wherein the crests of the corrugations of said first section are oblique to aid first longitudinal edge and the crests of the corrugations of said second section are oblique to the crests of said first section.

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